

The following table shows the results of the survey for the year 1998. The data is presented in a table with 10 columns: Country, Number of respondents, Percentage of respondents, and a description of the results. The table is divided into two main sections: "Number of respondents" and "Percentage of respondents". The "Number of respondents" section shows the number of respondents for each country, and the "Percentage of respondents" section shows the percentage of respondents for each country. The table is divided into two main sections: "Number of respondents" and "Percentage of respondents". The "Number of respondents" section shows the number of respondents for each country, and the "Percentage of respondents" section shows the percentage of respondents for each country.

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### COMPARING PERFORMANCE ON IMPLICIT MEMORY

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## 11. SUPPLEMENTARY NOTES

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During the past year grant related work has begun on five major projects and a similar number of projects less directly related to the original proposal, but still germane to it. Most of these concern the relation between measures of explicit and implicit memory performance, fulfilling the stated aims of the proposal. To cite some of our major findings during the first year of work, we have found that (a) priming on perceptual implicit memory tests can be boosted by imagery; (b) distinctive events that have powerful effects on explicit tests have little or no effect on perceptual priming; (c) a direct comparison of two methods for telling whether implicit memory tests are contaminated by conscious recollection both reveal that the tests are not contaminated, and (d) we have obtained some puzzling results (unlike those described above) which seem to indicate that repetition effects on implicit memory tests are more complicated than we had previously expected. Because we have just completed 12 months of a 36-month grant, some of the projects have not yet been completed. However, even after this first year, we plan to submit four papers on this work within the next few months. Most of the research conducted under the auspices of the grant has been at Armstrong Laboratories at Brooks AFB in San Antonio. This summer we have completed several pilot projects that will launch us on our second year's work at Armstrong Laboratories. Altogether, we tested some thirteen hundred subjects during the past year at Armstrong Laboratories, as well as several hundred more at Rice University, on these various projects. We believe we are making good progress toward our goals of the original proposal.

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20. LIMITATION OF ABSTRACT

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Annual Technical Report

Comparing Performance on Implicit Memory Tests  
(F49620-92-J-0437)

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### Summary

During the past year grant related work has begun on five major projects and a similar number of projects less directly related to the original proposal, but still germane to it. Most of these concern the relation between measures of explicit and implicit memory performance, fulfilling the stated aims of the proposal. To cite some of our major findings during the first year of work, we have found that (a) priming on perceptual implicit memory tests can be boosted by imagery; (b) distinctive events that have powerful effects on explicit tests have little or no effect on perceptual priming; (c) a direct comparison of two methods for telling whether implicit memory tests are contaminated by conscious recollection both reveal that the tests are not contaminated and (d) we have obtained some puzzling results (unlike those described above) which seem to indicate that repetition effects on implicit memory tests are more complicated than we had previously expected. Because we have just completed 12 months of a 36-month grant, some of the projects have not yet been pushed to completion. However, even after this first year, we plan to submit four papers based on this work within the next few months. Most of the research conducted under the auspices of the grant has been at Armstrong Laboratories at Brooks Air Force Base in San Antonio. This summer we have completed several pilot projects that will launch us on our second year's work at the Armstrong Laboratories. Altogether, we tested some thirteen hundred subjects during the past year at Armstrong Laboratories, as well as several hundred more at Rice University, on these various projects. We believe we are making good progress toward the goals of the original proposal.

### Description of Research

In my proposal, I outlined five lines of research that would be supported by this grant. We have made good progress on three of these lines of work that I will outline here in summary form. For purposes of an Annual Technical Report, I assume that summary statements are sufficient and that methodological details, tables and statistical analyses of results, etc. are not necessary. However, attached to this report are two

Master's theses that were supported by the grant work and one doctoral dissertation. Therefore, details of at least some of the studies are available in these places. I will describe here five main projects and then mention briefly a number of others ongoing under the auspices of the grant.

1. **Effects of exact and conceptual repetition on implicit and explicit memory tests.** Roediger and Challis (1992) compared performance on an implicit memory test (word fragment completion) with that on an explicit test (free recall), as a function of several types of repetition. Exact repetition is where a concept is repeated (*elephant* and then *elephant* later). Conceptual repetition refers to the case where the concept is repeated, but the exact form is not (for example, *elephant* is presented on one occasion, and *pachyderm* on the second). The prior work showed that conceptual repetition greatly affected free recall, but had no effect whatsoever on a perceptual implicit memory test (completing fragmented words, e\_ep\_a\_t). Seeing *elephant* once produced about .25 priming, and adding *pachyderm* later in the list had no effect on the magnitude of priming, unlike free recall. We are now conducting several other experiments using this basic paradigm to see if other implicit memory tests will behave similarly. We expect that perceptual implicit memory tests will show no effect of conceptual repetition, whereas conceptual implicit memory tests (and explicit memory tests) will show an effect of conceptual repetition. However, in our first experiment (with Kathleen McDermott) the results came out differently from our expectations. In particular, we are not finding that conceptual repetition affects performance on conceptual implicit memory tests (such as generating items to a category name). These results are problematic for the transfer appropriate processing theory that I have espoused and, if we can replicate the finding, suggest that modifications are in order. We plan at least one more experiment, and perhaps two, before this work is submitted (cited as McDermott & Roediger, in preparation, in the list below).

**2. Is there an effect of conscious recollection on implicit memory tests?** Many researchers worry about whether ostensibly implicit memory tests--thought to reflect automatic or even unconscious processes--really fulfill these claims. Some researchers believe that the tests are badly contaminated by conscious or explicit uses of memory. Two techniques have arisen to evaluate this problem. One is the retrieval intentionality criterion suggested by Schacter and his associates, and a second is called the process dissociation procedure and is advocated by Jacoby and his collaborators. The space here does not permit details of these methods, but each method has its attractions and demerits. At the moment, groups of researchers use one method or the other method, but not both. Another line of work we are conducting at Armstrong Laboratories is to directly compare these two methods. We are manipulating a variable (levels of processing) that sometimes has small effects on implicit memory tests and is often taken an index of whether an implicit test is contaminated by explicit or conscious recollection. We are testing large numbers of subjects under four different conditions that will allow us to directly compare the conclusions from the retrieval intentionality criterion and the process dissociation procedure. The results of a very sizable first experiment (testing some 240 subjects) are now in, and the data are wonderfully clear. The conclusions are that both the retrieval intentionality criterion and the process dissociation procedure are useful in distinguishing intentional from incidental retrieval; that both lead to similar conclusions; and that (at least under our test conditions) implicit memory tests are not contaminated by explicit recollection. We obtained no levels of processing effect whatsoever on perceptual priming. We plan to write up these results this fall and hope to have them submitted by winter (see the Jones, McDermott, & Roediger, in preparation, paper listed below).

**3. The effects of imagery on perceptual implicit memory tests.** In general, perceptual implicit memory tests are greatly affected by the method of presenting the stimuli, often in a manner quite different from explicit memory tests. For example, in almost all explicit memory tests pictures are better remembered than words. However, on

the word fragment and word completion tests, words produce more priming than do pictures; indeed, pictures often produce no priming at all. Conversely, on implicit memory tests involving fragmented picture cues, there is little or no priming from words. We (McDermott & Roediger, in preparation) have now conducted four experiments asking whether imagery affects perceptual priming. If subjects are given words and asked to form prototypic pictures from them (e.g., see the word *elephant* and imagine an elephant) is reliable priming obtained on a picture fragment identification test? Similarly, if subjects are given a picture and asked to form an image of what the word would look like typed, is priming obtained on an implicit word fragment completion task? The answer to both questions is *Yes*. The complete set of results is contained in a Master's thesis by McDermott, in the Appendix. This work will be submitted very shortly to the *Journal of Experimental Psychology: Learning, Memory, and Cognition*, and is listed below as McDermott and Roediger (in preparation).

4. **Effects of distinctiveness on intentional and incidental retrieval.** Another line of work concerns the effect of distinctive events on memory. It is well known that a distinctive event against the background of ordinary events greatly facilitates conscious recollection. For example, if a picture is put in a list of 99 words, it is very well remembered relative to the same picture being placed in the midst of 99 other pictures. Similar processes seem to be at work in producing so called flashbulb memories, where we remember things that occur under surprising circumstances. We (Guynn & Roediger, in preparation) have now conducted four experiments that ask whether distinctiveness also affects performance on perceptual implicit memory tests. Three experiments have been completed and subjects have been tested for the fourth, but analyses are still ongoing as of this writing. However, the general conclusion that seems to be emerging is that whereas distinctive events seem to have powerful effects on explicit memory tests, the effects on perceptual priming in implicit tests are at best small and may be nonexistent. The details of these experiments are contained in the attached Master's thesis by Melissa J. Guynn,

although a fourth experiment will be added to it after it is analyzed. Publication of these experiments is planned for a special issue of *Psychological Research* (a leading European journal of cognitive psychology) when the fourth experiment is completed.

5. **Priming of novel objects.** Dan Schacter, Lynn Cooper and their collaborators have reported an interesting finding in that no priming occurs on an object decision task (deciding whether a briefly presented object is possible or impossible to construct in the real world) from impossible objects. They have argued that one must be able to make contact with a structural description perceptual memory system in order to produce priming on this task. Impossible objects do not produce priming because they cannot be completely analyzed by this system. Another possibility is that specific features of their decision task cause the problem with finding priming from impossible items, rather than lack of contact with a structural decision system. Todd Jones and I are just beginning pilot work on the possible and impossible objects (kindly supplied to us by Schacter and Cooper) to see if, with other methods of testing, impossible objects will continue to yield no priming. However, this line of research is just getting under way.

Listed above are the five main lines of work that have been supported by the grant proposal. However, a number of other related projects have also been supported and we have used the facilities of Armstrong Laboratories to test subjects for these. These projects include the following. (a) Types of recollective experience (Remembering or Knowing) as a function of serial position (with Todd Jones); (b) a new procedure for testing recognition memory by asking subjects to look for and to circle new items rather than the customary procedure of attempting to identify old items (with Kathleen McDermott); (c) effects of repeated testing on memory, both for word lists and in an eyewitness memory situation (both projects with Kathleen McDermott and Ryan Brown); (d) a further experiment, conducted by Melissa Guynn and Gilles Einstein, concerns prospective memory. Some work from this project may find its way into a small chapter Guynn and I have been asked to write for a forthcoming book edited by G. O. Einstein

and M. A. McDaniel on prospective memory; (e) spontaneous recovery in memory. This project was conducted by Mark Wheeler as part of his dissertation work and although tangentially related to the direct goals of the grant proposal, was supported in that he tested subjects at the Armstrong Laboratories. He will thank the grant in any ensuing publication. The paper has been submitted to the *Journal of Experimental Psychology: Learning, Memory, and Cognition*.

In sum, the first year of research in collaboration with people at Armstrong Laboratories has gone smoothly and we have made good progress on the objectives for the grant.

#### Publications: Articles and Chapters

The list below is of articles and chapters published under support of the grant. These include some articles supported by my prior grant from AFOSR (91-NL-038).

#### In press

Rajaram, S., & Roediger, H. L. Remembering and knowing as states of consciousness during recollection. In J. D. Cohen & J. Schooler (Eds.), The Carnegie-Mellon Symposium on consciousness and cognition. Hillsdale, N. J.: Erlbaum.

Roediger, H. L., Guynn, M. J., & Jones, T. C. Implicit memory: A tutorial review. In P. Eelen & G. d'Ydewalle (Eds.), Contributions to the Brussels International Congress of Psychology. Hillsdale, N. J.: Erlbaum.

Roediger, H. L., & McDermott, K. B. Implicit memory in normal human subjects. In F. Boller & J. Grafman (Eds.), Handbook of neurology, Vol. 8. Amsterdam: Elsevier.

Roediger, H. L., Wheeler, M. A., & Rajaram, S. Remembering, knowing and reconstructing the past. In D. L. Medin (Ed.), The psychology of learning and motivation: Advances in research and theory. New York: Academic Press.

#### Submitted

Roediger, H. L., & McDermott, K. B. The problem of differing false alarm rates for the process dissociation procedure: Comment on Verfaellie and Treadwell (1993). Submitted to Neuropsychology.



Wheeler, M. A. Improvement in recall over time without repeated testing: Spontaneous recovery revisited. Submitted to Journal of Experimental Psychology: Learning, Memory, and Cognition.

#### In Preparation

Guynn, M. J., & Roediger, H. L. High-priority events: Effects on free recall, word stem completion, and word stem cued recall.

Jones, T. C., McDermott, K. B., & Roediger, H. L. Direct comparison of Jacoby's process dissociation procedure and Schacter's retrieval intentionality criterion as methods of assessing test differences.

McDermott, K. B., & Roediger, H. L. Effects of exact and conceptual repetition on implicit and explicit memory tests.

McDermott, K. B., & Roediger, H. L. Effects of imagery on perceptual implicit tests of memory.

Roediger, H. L., & Guynn, M. J. Retrieval processes. To appear in E. L. Bjork and R. A. Bjork (Eds.), Memory. Volume 10 of the Handbook of perception and cognition. New York: Academic Press.

#### Names of Participating Professionals

Listed here are the names of people who worked under the auspices of the grant during its first year.

(1) Henry L. Roediger, III; Principal Investigator. Lynette S. Autry Professor of Psychology at Rice University, Ph.D., 1973, from Yale University.

(2) Melissa J. Guynn; Graduate student; Rice University; B.S., in Psychology, Furman University, 1991. M.S. candidate at Rice, 1993. I planned to support her from this grant during its first year; however, she won a National Science Foundation Fellowship and therefore saved the grant money.

(3) Todd C. Jones; Graduate student; Rice University; B.S. and M.S. in Psychology from Southern Methodist University in 1990 and 1991, respectively

(4) Kathleen B. McDermott; Graduate student; Rice University, B.S. in Psychology, University of Notre Dame, 1990. M.S. candidate at Rice, 1993. She will defend her thesis on September 10. It is included here.

(5) Mark A. Wheeler; Graduate student; Rice University; B.S. in Psychology from Trinity University, 1989; M.S. in Psychology from Rice, 1991; Ph.D. in Psychology from Rice, 1993. Mark's research on spontaneous recovery was conducted partly at Armstrong Laboratories and therefore was supported by the grant.

(6) Jody Hughes; undergraduate student; Rice University; B.A. in English Literature is expected in 1994. Jody became interested in psychology through taking my course on human memory and worked during the summer as an undergraduate research assistant.

(7) Ryan Brown; B.S. in Psychology, Rice University, 1993. Ryan was another undergraduate who worked as a research assistant during the summer. He is enrolling in the social psychology program at the University of Texas.

(8) Nicole Cornette; B.S. in Education, University of Nebraska, 1991. Nicole was a part-time clerical worker/research assistant for 1992-1993 working on grant-related projects.

#### Presentations at Professional Meetings

Listed below are presentations made at professional meetings by me or the four graduate students who worked on grant-related projects.

McDermott, K. B. (1993). Effects of imagery on perceptual implicit memory tests. Texas Cognition Conference, Fort Worth.

Roediger, H. L. (1992). Specificity of operations in perceptual priming. Memory Disorders Research Society, Boston.

Roediger, H. L. (1993). A new technique for studying reconstructive memory. The Weiskrantz Symposium on Memory. Baylor University, Waco.

Roediger, H. L. (1993). Remembering, knowing, and reconstructing past events. Presidential address, Midwestern Psychological Association, Chicago.

Roediger, H. L., Wheeler, M. A., & Challis, B. H. (1992). Effects of confabulation on later recall. The Psychonomic Society, St. Louis.

#### New Inventions, Patents, etc.

Although there were certainly new discoveries during the first year of this grant, there were none that involved inventions or any work that would be patented.

#### Additional Statement

I feel we have made considerable progress towards attaining the goals of the proposal "Comparing Performance on Implicit Memory Tests." During the upcoming year we will be beginning new projects concerned with Sections 4 and 5 of the original proposal. These are, respectively, (4) investigations of factors affecting priming on conceptual implicit memory tests, and (5) individual differences (both in subjects and in materials) and how these affect priming on implicit memory tests. In sum, the first year of support under AFOSR grant F49620-92-J-0437 has been most productive. I and my graduate students are quite appreciative of this excellent support, which has enabled us to make considerable progress towards these stated goals.

Henry L. Roediger, III